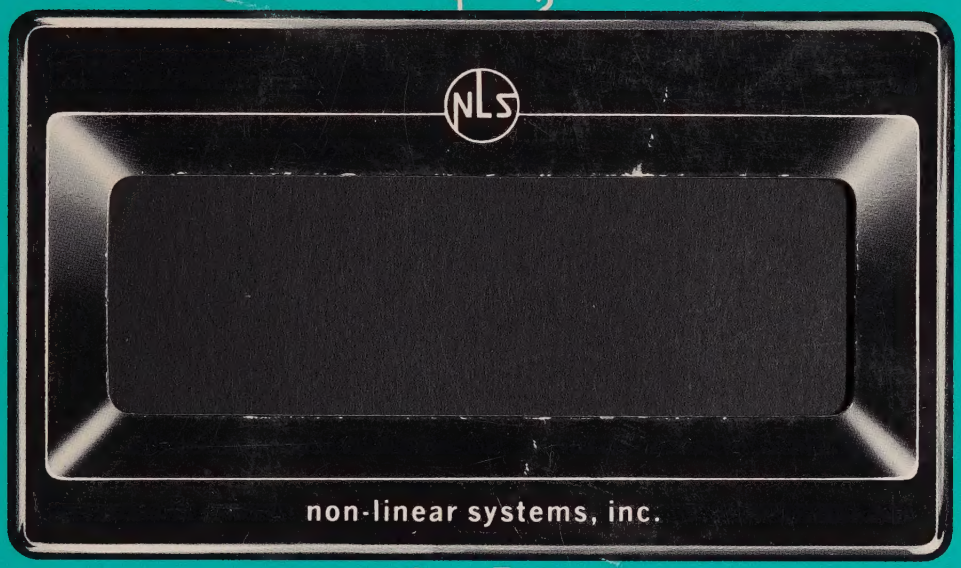

GENERAL ELECTRIC CO
Instrume & Control
228 Hyde Park Ave.
Inglewood, Calif. 90301

Electronic Services - Los Angeles
M13730X

non linear systems, inc.

DEL MAR, CALIFORNIA

Document No. 934

January 1968

OPERATION AND CALIBRATION INSTRUCTIONS

SERIES X-3

DIGITAL VOLTMETER

GENERAL ELECTRIC CO.
Instrumentation & Control
228 W. Florence Ave.
Inglewood, Calif. 90301

This Document applies to Series X-3 DVM
bearing P/N 38-3 (S/N X-3-306 & Subsequent)

NON-LINEAR SYSTEMS, INC.

Del Mar, California

Printed in the United States of America

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NOTICE

AFTER UNPACKING THE INSTRUMENT AND CABLES, NOTE AND RECORD BELOW THE SERIAL NO. OF THE INSTRUMENT AND THE SERIAL NO. OF THE AC PROBE CABLE, P/N 38-50. THE INSTRUMENT SHIPPED WITH THIS INSTRUCTION MANUAL HAS BEEN CALIBRATED IN THE VAC MODE WITH THE PARTICULAR AC PROBE CABLE INCLUDED IN THE SHIPMENT. IF ANY OTHER AC PROBE CABLE IS USED WITH THIS INSTRUMENT, THE INSTRUMENT MUST FIRST BE RE-CALIBRATED TO THAT PARTICULAR AC PROBE CABLE (SEE CHAPTER III, CALIBRATION INSTRUCTIONS).

SERIAL NO. OF INSTRUMENT X-3.332

SERIAL NO. OF AC CABLE X-3.289

PURCHASED 1-18-68 R.M.

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Final Assembly, DVM ..... 38-3, Sheet 2

CHAPTER I

INTRODUCTION AND SPECIFICATIONS

The Series X-3 Multipurpose Digital Voltmeter is a light weight, portable, three-digit instrument with automatic polarity and with provisions for 100% over-ranging in all ranges and all functions.

The measuring capabilities of the Series X-3 DVM are widely varied, i.e. nine current ranges, three millivolt (DC) ranges, three VDC ranges, three VAC ranges and nine ohms ranges.

In addition to the digital readout, a unique feature of this instrument, compared to conventional meter-type VTVM's and multimeters, analog output connectors are provided on the rear of the instrument.

Also, compared to conventional meters of this versatile nature, the Series X-3's circuitry is all solid state and its speed and accuracies are considerably higher.

SPECIFICATIONS

DC VOLTAGE

RANGE	OVER-RANGE	RESOLUTION	ACCURACY*
10 mV	19.99 mV	10 μV	0.2% Rdg. + 10 Digits
100 mV	199.9 mV	100 μV)	
1000 mV	1999. mV	1 mV)	
10 V	19.99 V	10 mV)	0.1% Rdg. + 1 Digit
100 V	199.9 V	100 mV)	
1000 V	999.9 V	1 V)	
10000 V (With Probe)		10 V	3% Rdg. + 2 Digits

DC CURRENT

10 nA	19.99 nA	10 pA	20% Rdg. + 10 Digits
100 nA	199.9 nA	100 pA	5% Rdg. + 10 Digits
1000 nA	1999. nA	1 nA	0.5% Rdg. + 10 Digits
10 μA	19.99 μA	10 nA	0.2% Rdg. + 1 Digit
100 μA	199.9 μA	100 nA)	
1000 μA	1999. μA	1 μA)	0.1% Rdg. + 1 Digit
10 mA	19.99 mA	10 μA)	
100 mA	199.9 mA	100 μA)	

* ASA Reference Conditions Only

OHMS

RANGE	OVER-RANGE		RESOLUTION	ACCURACY*
10Ω	19.99Ω	@10 mA	10 mΩ	0.1% Rdg. + 2 Digits
100Ω	199.9Ω	@1 mA	100 mΩ)	
1000Ω	1999Ω	@100 μA	1Ω)	0.1% Rdg. + 1 Digit
10 KΩ	19.99 KΩ	@10 μA	10Ω)	
100 KΩ	199.9 KΩ	@1 μA	100Ω)	
1000 KΩ	1999 KΩ	@100 nA	1 KΩ	0.5% Rdg. + 1 Digit
10 MegΩ	19.99 MegΩ	@100 nA	10 KΩ	1% Rdg. + 2 Digits
100 MegΩ	199.9 MegΩ	@10 nA	100 KΩ	20% Rdg. + 5 Digits
1000 MegΩ	1999 MegΩ	@1 nA	1 MegΩ	Usable for relative measurements

AC VOLTAGE

10 V	19.99 V	10 mV	3% F.S. (0.5 V & Up) **
100 V	199.9 V	100 mV	3% F.S.**
1000 V (300 V maximum)		1 V	3% F.S.**

POWER-105-125 Volts, 20 Watts - 30 Watts with optional power supply loaded.

DIMENSIONS - 10-1/2" High, 7-3/8" Wide, 6" Deep

WEIGHT - 10-1/2 lbs.

* ASA Reference Conditions Only ** @400 Hz

CHAPTER II

OPERATING INSTRUCTIONS

UNPACKING

The instrument is shipped in a heavy cardboard container. Cut the tape on the top of the container and open. If damage is seen, promptly notify the carrier.

POWER SOURCE

The instrument is usually supplied for operation from 105-125-volt, 50-400 Hz, single phase power sources. However, the instrument will operate from 210-250-volt, 50-400 Hz, single phase sources if the two primaries of the power transformer are wired in series instead of in parallel. The serial No. tag at the rear of the instrument indicates the correct power source if other than 105-125 volts or 50-400 Hz.

FUSING

The instrument is protected by a 3AG 3/8 ampere fuse (F1) which is located on the rear panel. When a 210-250-volt power source is to be used (and the power transformer primary rewired as indicated above), it is recommended that a 3/16 ampere fuse be used to provide maximum protection. An additional fuse (F2), also located in an extractor post on the rear panel, is provided to guard the ohms input circuit against any inadvertent application of voltage or current into the ohms input connector.

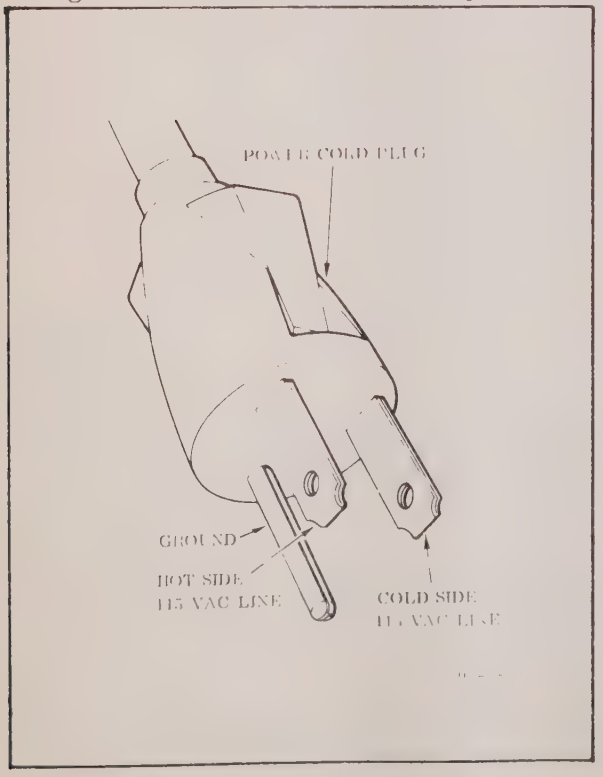


Figure 2-1. Power Plug Pin Coding

POWER GROUNDING

The third pin of the power plug grounds the outer chassis of the instrument (Figure 2-1). Despite the presence of the third grounding pin, there is no real assurance that the instrument will be correctly connected since the power outlets in many installations are erroneously wired. Be certain that the power source is in agreement with the power and grounding requirements of the instrument.

CONNECTORS

Eight input connectors are located on the front panel of the instrument; they are color-coded and labeled as to function:

AC PROBE------Phone Jack (no color)

OHMS----------Blue

CURRENT-------Yellow

COM. ---------- Black

VDC---------- Red

+ ---------- Green

— ---------- Green

⏚ ---------- Green

NOTE

The green connectors are ONLY to be used for the insertion of the optional PS-1 Power Supply plugs.

Two connectors are located on the rear panel: they provide the analog output of the instrument (10 μA maximum). The red connector is signal high; the black connector is signal low.

CABLES

Six cables are provided with each instrument: the part number, color and function of each are as follows:

15001-608-1	Yellow	Current
15004-608-2	Blue	Ohms
15004-608-3	Black	Common
15004-609	Red	VDC
38-50	Black with Silver Probe	AC Probe
38-75	Black with Red Probe	VDC High Voltage Probe

CONTROLS

FUNCTION SWITCH

The function switch is a nine-position switch, located on the front panel of the instrument. The position for each measurement function is appropriately labeled (See Table I)

RANGE SWITCH

The range switch is a three-position switch, located on the front panel of the instrument. The positions for each range measurement are labeled L, M, and H (See Table I).

ON DISPLAY

The ON DISPLAY control, located on the front panel of the instrument, serves as a power switch and as a control to permit noisy input signals to be measured (turn clockwise)

Table I. Measurement Capabilities

FUNCTION SWITCH POSITION	RANGE SWITCH POSITION		
	L	M	H
nA	10 nA RANGE →	100 nA RANGE →	1000 nA RANGE
μA	10 μA RANGE →	100 μA RANGE →	1000 μA RANGE
mA	10 mA RANGE →	100 mA RANGE (200 mA Max.)	NON-OPERATING (Use with External Shunt only)
MV	10 mVDC RANGE →	100 mVDC RANGE →	1000 mVDC RANGE
VDC	10 VDC RANGE (0.5V MIN.) →	100 VDC RANGE →	1000 VDC RANGE (10KV WITH PROBE)
VAC	10 VAC RANGE →	100 VAC RANGE →	1000 VAC RANGE
Ω	10 Ω RANGE →	100 Ω RANGE →	1000 Ω RANGE
KΩ	10 KΩ RANGE →	100 KΩ RANGE →	1000 KΩ RANGE
MEGΩ	10 MEGΩ RANGE →	100 MEGΩ RANGE →	1000 MEGΩ RANGE
100 % OVER-RANGE ON ALL RANGES			

NOTE: WHEN INSTRUMENT INDICATES 1999,RANGE/FUNCTION SWITCHES SHOULD BE ROTATED AS INDICATED BY ARROWS UNTIL A READING IS OBTAINED BETWEEN 0199 AND 1998. THIS WILL BE THE PROPER RANGE AND THE MOST ACCURATE READING OF WHICH THE INSTRUMENT IS CAPABLE WILL BE DISPLAYED.

AC ZERO

The AC ZERO control, located on the front panel of the instrument, is provided to zero the readout prior to taking VAC readings.

DC & OHMS ZERO

The DC & OHMS ZERO control, located on the front panel of the instrument, is provided to zero the readout prior to taking current, MVDC, VDC or ohms readings.

FILTER SWITCH

The FILTER switch is a two position toggle switch and is located on the front panel of the instrument. It is labeled IN and OUT and is provided to attenuate noisy input signals. In the higher resistance ranges, the filter may be switched out to obtain faster readings.

DIGITAL READOUT

The instrument is supplied with five readout tubes: polarity (+ or -) and overload (O_L) display: over-range (1) display; and three 0 thru 9 digital and decimal displays (left to right respectively). The O_L display will illuminate when the input reaches 100% over-range of each range limit for each measurement function.

OPERATION

1. Plug power cord into 115VAC, 60 Hz, single phase power source.
2. Turn ON DISPLAY control clockwise until an audible click is heard. Allow 30 minutes for instrument warm-up.
3. Place function switch in the position (as labeled) to obtain desired function to be measured (See Table I).
4. Place range switch in position to obtain desired range to be measured (See Table I).

NOTE

To obtain accurate measurements, within instrument's specified accuracies, it is essential that the readout of the instrument be brought to all zeros prior to operation and prior to measurement after EACH range OR function change.

ZEROING THE READOUT

MVDC or VDC Zero

1. Place function switch in mV or VDC position.
2. Plug red and black input cables into their matching-color connectors.
3. Connect leads of cables together and adjust DC & OHMS ZERO control until readout displays all zeros.

Current Zero

1. Place function switch in nA, μA or mA position.
2. Plug yellow and black input cables into their matching-color connectors.
3. With leads of cables open, adjust DC & OHMS ZERO control until readout displays all zeros.

Ohms Zero

1. Place function switch in Ω, KΩ, or MEGΩ position.
2. Plug blue and black input cables into their matching-color connectors.
3. Connect leads of cables together and adjust DC & OHMS ZERO control until readout displays all zeros.

AC Zero

1. Plug VAC cable into AC PROBE connector. Allow 5 minutes for warm-up.
2. Zero the instrument in VDC mode as set forth above.
3. Place function switch in VAC position.
4. Connect leads of cable together and adjust AC ZERO control until readout displays all zeros.

FILTER SWITCH

Place filter switch in the IN position for measurement of all low frequency signals.

CABLE CONNECTIONS

For signal measurement, connect instrument cables to signal source as shown in applicable calibration instructions (Figures 3-4 thru 3-7).

NOTE

Since the circuitry in the Series X-3 Digital Voltmeter is not connected to power ground, differential measurements above ground may be made. However, the signal to be measured, should first be analized to determine which terminal has the lowest impedance to ground so that the black input lead of the X-3 may be connected to it.

CHAPTER III

CALIBRATION INSTRUCTIONS

EQUIPMENT REQUIRED

1. A voltage standard between 10 MVDC and 1000 VDC.
2. A current source between 10μA and 150μA.
3. An audio voltage standard between 10 VAC, 400 Hz and 300 VAC, 400 Hz.
4. An ohms standard between 10Ω and 15 MegΩ
5. An oscilloscope, Tektronix Model 502, or equivalent.
6. A Dekavider, Model DV-411, Electronic Scientific Industries, or equivalent.
7. A voltmeter capable of measuring 6.3 VDC.

INITIAL PREPARATION

1. Remove the four screws attaching the rear plate to top block and base block (two from each).
2. Remove two screws from bottom of instrument attaching base block to chassis.
3. Remove five knobs from front of instrument.
4. Gently withdraw chassis from rear of instrument's outer case.
5. Plug power cord into 115VAC, 60 Hz, single phase power source.
6. Turn ON DISPLAY control clockwise until an audible click is heard. Allow 30 minutes for instrument warm-up.
7. In each step, as applicable in the following procedures, allow warm-up time for each item of test equipment as per manufacturers requirements.

PROCEDURE

1. Place ON DISPLAY potentiometer on front of instrument (right-most potentiometer) in center of its travel.
2. Place a voltmeter between 6.3V test point and Signal ground (Figure 3-1). Check to ensure that voltmeter indicates an input of 6.3 VDC ±5%.
3. Place range switch of instrument in H position.
4. Place function switch of instrument in mV position.
5. Connect input cables to connectors on front of instrument as follows (connectors are labeled on front panel):

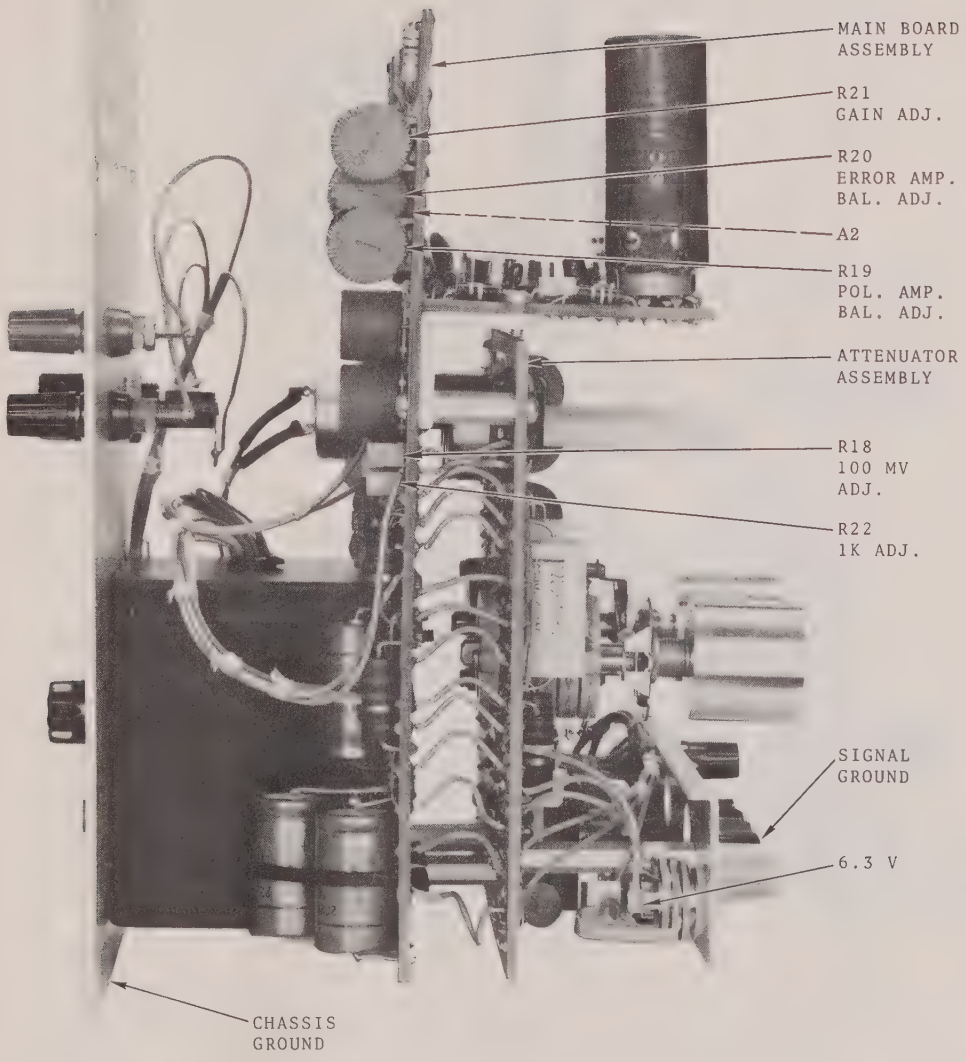


Figure 3-1. Left View

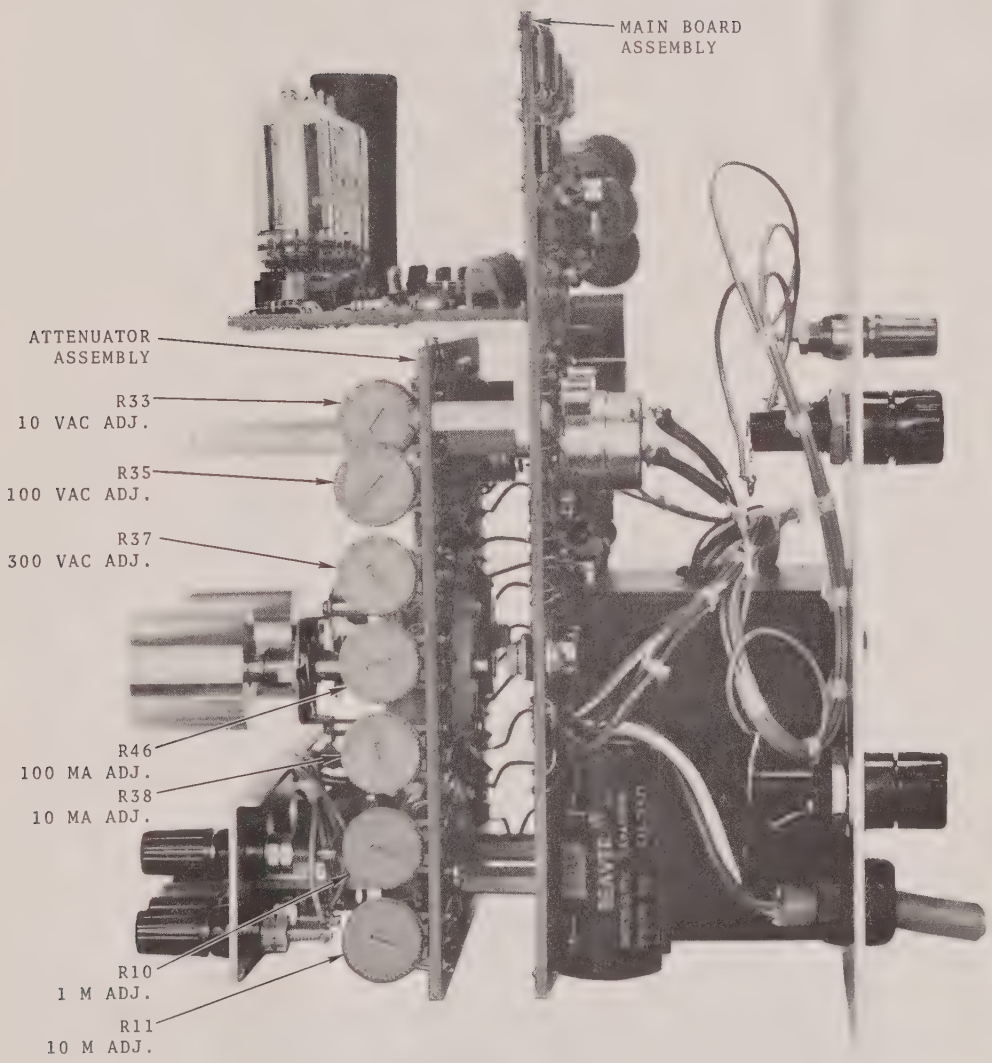


Figure 3-2. Right View

Red Cable ---------- VDC

Black Cable ---------- COM

Yellow Cable ---------- CURRENT

Blue Cable ---------- OHMS

Black Cable (with probe)---- AC PROBE

6. Connect input leads of oscilloscope to a ANALOG OUTPUT connectors on rear of instrument.

7. Set oscilloscope sensitivity to 1 MV/CM.

8. Connect red and black (VDC and COM) input leads together.

9. Rotate DC and OHMX ZERO potentiometer on front of instrument (center potentiometer) until oscilloscope indicates a zero reading.

10. Connect input leads of oscilloscope to pin 6 of polarity amplifier A2 of Main Board Assembly and chassis ground (Figure 3-1).

11. Set oscilloscope sensitivity to 200 MV/CM.

12. Adjust R19 of Main Board Assembly (Figure 3-1) until oscilloscope shows zero deflection.

13. Adjust R20 of Main Board Assembly (Figure 3-1) until DVM readout just changes from 0001. to 0000.

14. Repeat steps 12 and 13 until both oscilloscope and DVM readout indicate a zero reading.

15. Disconnect oscilloscope leads.

16. Rotate DC and OHMS ZERO potentiometer until DVM starts counting down.

17. Adjust R21 of Main Board Assembly (Figure 3-1) until DVM counts down one digit at a time.

18. Connect red and black input leads together.

19. Adjust DC and OHMS ZERO potentiometer until readout displays all zeros.

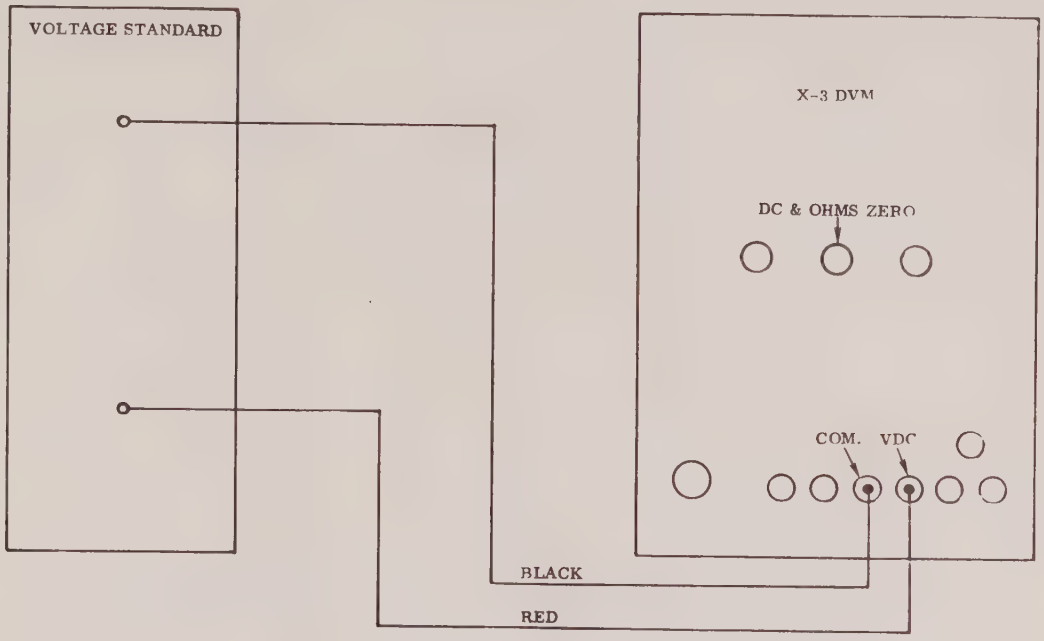
20. Place range switch in M position.

21. Connect red and black input leads to voltage standard. Apply approximately -150MV.

22. Reverse polarity of signal input and check to see that the numerical value displayed in readout is identical (±2 digits), in either polarity, with the same voltage applied.

23. Instructions for range calibration in each mode of operation are contained in Figures 3-4 and 3-7.

24. When calibration is complete, reassemble instrument in reverse order of disassembly. When inserting chassis into instrument's outer case, use care in guiding the control shafts into their respective holds in the front panel of the instrument.



NOTE

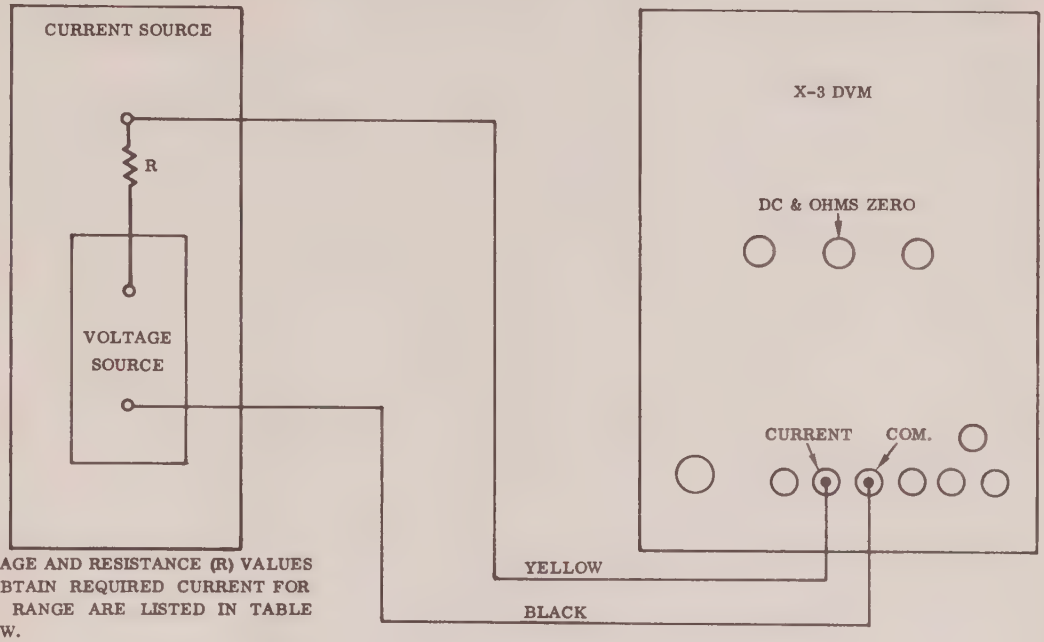
PRIOR TO EACH RANGE OR FUNCTION CHANGE, ZERO THE READOUT IN MVDC OR VDC MODE (REFER TO CHAPTER II, ZEROING THE READOUT MVDC or VDC Zero).

PROCEDURE

FUNCTION SWITCH POSITION	RANGE SWITCH POSITION	APPLY APPROXIMATELY	ADJUST	LOCATION* (Figure No.)	READOUT TO DISPLAY VOLTAGE APPLIED, WITHIN
mV	H	1500 mV	R12	3-1 (MB)	0.1% RDG + 1 DIGIT
mV	M	150 mV	R12	3-1 (A)	0.1% RDG + 1 DIGIT
mV	L	15 mV	R7	3-1	0.2% RDG + 10 DIGITS
VDC	L	15 VDC	R21	3-1	0.1% RDG + 1 DIGIT
		WARNING HIGH VOLTAGE			
VDC	M	150 VDC	R18	3-1	0.1% RDG + 1 DIGIT
VDC	H	950 VDC	R11	3-1	0.1% RDG + 1 DIGIT

* MB = MAIN BOARD ASSEMBLY
A = ATTENUATOR ASSEMBLY

Figure 3-3. MVDC and VDC Calibration



VOLTAGE AND RESISTANCE (R) VALUES TO OBTAIN REQUIRED CURRENT FOR EACH RANGE ARE LISTED IN TABLE BELOW.

NOTES

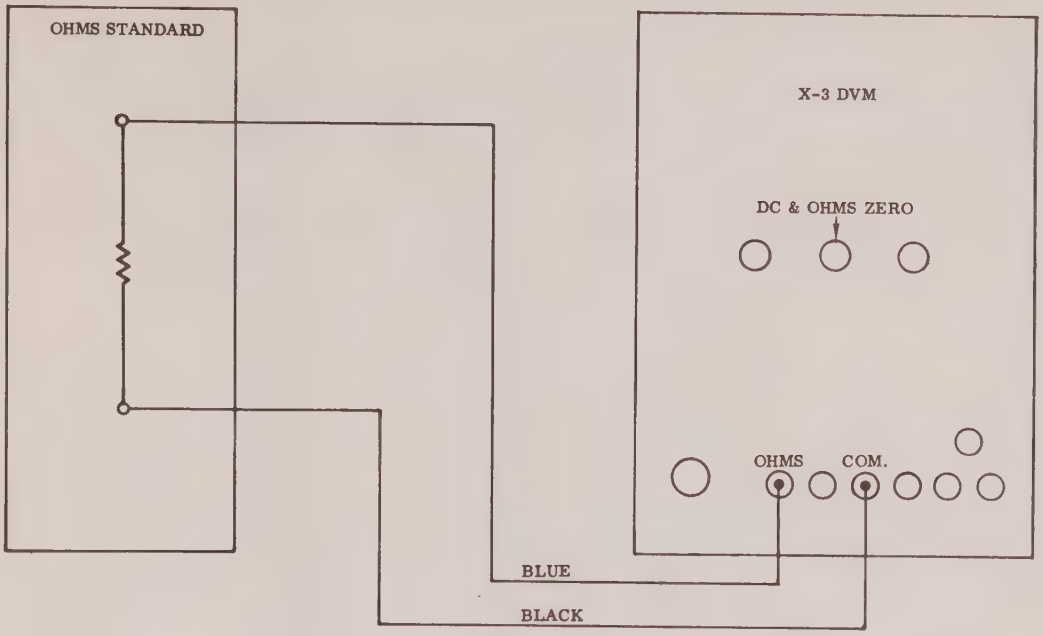
1. INSTRUMENT MUST FIRST BE CALIBRATED IN MVDC AND DC MODES.
2. PRIOR TO EACH RANGE OR FUNCTION CHANGE, ZERO THE READOUT IN THE CURRENT MODE (REFER TO CHAPTER II, ZEROING THE READOUT, Current Zero).

PROCEDURE

FUNCTION SWITCH POSITION	RANGE SWITCH POSITION	CURRENT TO BE APPLIED			ADJUST	LOCATION* (FIGURE NO.)	READOUT TO DISPLAY CURRENT APPLIED WITHIN
			VOLTS (±0.02)	R (±0.02%)			
nA	L	15 nA	0.165 V	10 M	NONE	---	20% RDG. + 10 DIGITS
nA	M	150 nA	1.515 V	10 M	NONE	---	5% RDG. + 10 DIGITS
nA	H	1500 nA	15.015 V	10 M	NONE	---	0.5% RDG. + 10 DIGITS
μA	L	15 μA	15.150 V	1 M	NONE	---	0.2% RDG. + 1 DIGIT
μA	M	150 μA	15.150 V	100 K	NONE	---	0.1% RDG. + 1 DIGIT
μA	H	1500 μA	15.150 V	10 K	NONE	---	0.1% RDG. + 1 DIGIT
mA	L	15 mA	15.150 V	1 K	R38	3-2 (A)	0.1% RDG. + 1 DIGIT
mA	M	150 mA	15.210 V	100 Ω	R46	3-2 (A)	0.1% RDG. + 1 DIGIT

CAUTION: DO NOT APPLY MORE THAN 200 mA or DAMAGE TO THE INSTRUMENT MAY RESULT.
*A= ATTENUATOR ASSEMBLY

Figure 3-4. Current Calibration



NOTES

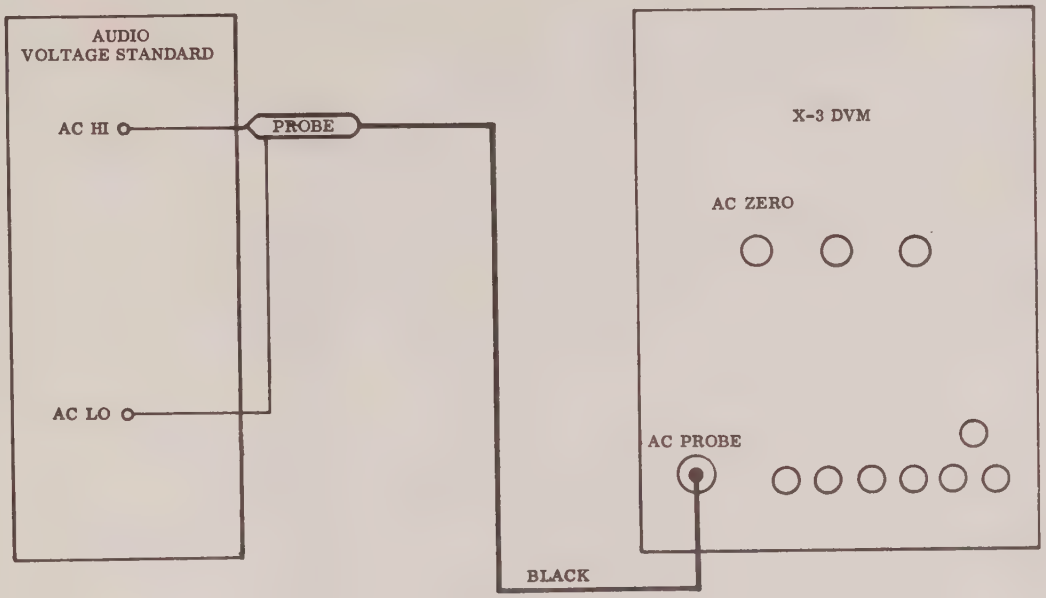
1. INSTRUMENT MUST BE FIRST CALIBRATED IN MVDC & DC MODES.
2. PRIOR TO EACH RANGE OR FUNCTION CHANGE, ZERO THE READ-OUT IN OHMS MODE (REFER TO CHAPTER II, ZEROING THE READ-OUT, Ohms Zero).

PROCEDURE

FUNCTION SWITCH POSITION	RANGE SWITCH POSITION	APPLY APPROXIMATELY	ADJUST	LOCATION* (Figure No.)	READOUT TO DISPLAY OHMIC VALUE APPLIED, WITHIN
Ω	H	1500 Ω	R22	3-1 (MB)	0.1% RDG + 1 DIGIT
Ω	M	150 Ω	NONE	---	0.1% RDG + 1 DIGIT
Ω	L	15 Ω	NONE	---	0.1% RDG + 2 DIGITS
KΩ	L	15 KΩ	NONE	---	0.1% RDG + 1 DIGIT
KΩ	M	150 KΩ	NONE	---	0.1% RDG + 1 DIGIT
KΩ	H	1500 KΩ	R10	3-2 (A)	0.5% RDG + 1 DIGIT
MEGΩ	L	15 MEGΩ	R11	3-2 (A)	1% RDG + 5 DIGITS
MEGΩ	M	150 MEGΩ	NONE	---	20% RDG + 5 DIGITS
MEGΩ	H	1500 MEGΩ	NONE	---	USEABLE FOR RELATIVE MEASUREMENTS

*MB = MAIN BOARD ASSEMBLY
A = ATTENUATOR ASSEMBLY

Figure 3-5. Ohms Calibration



NOTES

1. INSTRUMENT MUST FIRST BE CALIBRATED IN VDC MODE.
2. ZERO READOUT IN VDC MODE (REFER TO CHAPTER II, ZEROING THE READOUT, MVDC OR VDC Zero).
3. PRIOR TO EACH RANGE OR FUNCTION CHANGE, ZERO THE READOUT IN VAC MODE (REFER TO CHAPTER II, ZEROING THE READOUT, VAC Zero).

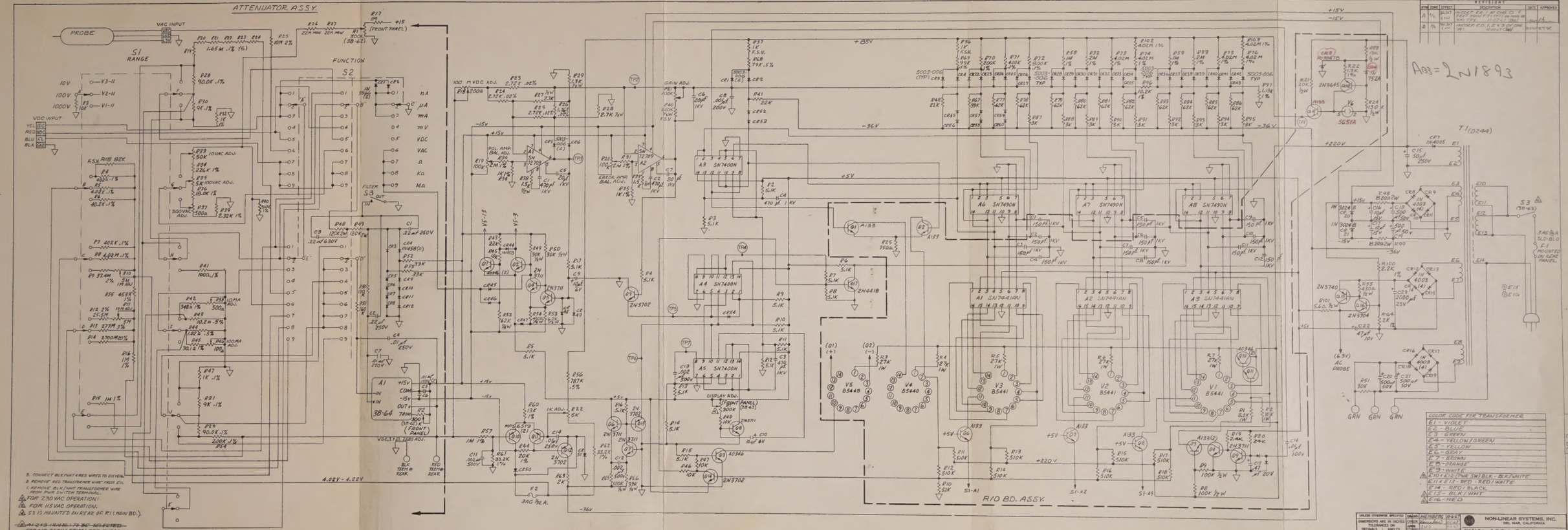
PROCEDURE

FUNCTION SWITCH POSITION	RANGE SWITCH POSITION	APPLY APPROXIMATELY	ADJUST	LOCATION*	READOUT TO DISPLAY VOLTAGE APPLIED, WITHIN
VAC	L	15 VAC, 400 Hz WARNING HIGH VOLTAGE	R33	3-2 (A)	3% F.S. (0.5V & UP)
VAC	M	150 VAC, 400 Hz	R35	3-2 (A)	3% F.S.
VAC	H	250 VAC, 400 Hz	R37	3-2 (A)	3% F.S.

CAUTION
DO NOT APPLY MORE THAN
300 VAC OR DAMAGE TO THE INSTRUMENT MAY RESULT

* A = Attenuator Assembly

Figure 3-6. VAC Calibration



SYM	ZONE	EFFECT	DESCRIPTION	DATE	APPROVED
A	Y/L	38-37 & 38-63	MODIFIED PER E.C.O. 0-5 FIRST PRINT Y/L (1971) SHOWN IN MAY 1972		
B	Y/L	38-37 & 38-63	PER ECO 0-1, 2 & 3 OF 1972 SHOWN IN		

COLOR CODE FOR TRANSFORMER
E1 - VIOLET
E2 - BLUE
E3 - GREEN
E4 - YELLOW/GREEN
E5 - YELLOW
E6 - GRAY
E7 - BROWN
E8 - ORANGE
E9 - WHITE
E10 (E12 PWR SW) BLK - BK/WHITE
E11 (E13 - RED - RED/WHITE
E14 - RED/BLACK
E15 - BLK/WHT
E16 - RED

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FINAL ASSY, DVM
SCHEMATIC
SERIES X-3

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